TECHNICAL PROGRESS REPORT

for

APRIL-JUNE 2007
NOVEL CONCEPTS RESEARCH IN GEOLOGIC STORAGE OF CO_2
PHASE III

THE OHIO RIVER VALLEY CO_2 STORAGE PROJECT

Contract No. DE-AC26-98FT40418

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ABSTRACT

As part of the Department of Energy's (DOE) initiative on developing new technologies for the storage of carbon dioxide (CO_2) in geologic reservoirs, Battelle has been investigating the feasibility of CO_2 sequestration in the deep saline reservoirs of the Ohio River Valley region. In addition to the DOE, the project is being sponsored by American Electric Power (AEP), BP, Ohio Coal Development Office (OCDO) of the Ohio Air Quality Development Authority, Schlumberger, and Battelle. The main objective of the project is to demonstrate that CO_2 sequestration in deep formations is feasible from engineering and economic perspectives, as well as being an inherently safe practice and one that will be acceptable to the public. In addition, the project is designed to evaluate the geology of deep formations in the Ohio River Valley region in general and in the vicinity of AEP's Mountaineer Power Plant, in order to determine their potential use for conducting a long-term test of CO_2 disposal in deep saline formations.

The current technical progress report summarizes activities completed for the April-June 2007 period of the project. As discussed in the report, the main accomplishments related to preparation to move forward with a 100,000-300,000 metric tons CO_2/year capture and sequestration project at the Mountaineer site. The program includes a 10 to 30-megawatt thermal product validation at the Mountaineer Plant where up to 300,000 metric tons CO_2/year will be captured and sequestered in deep rock formations identified in this work. Design and feasibility support tasks such as development of injection well design options, engineering assessment of CO_2 capture systems, permitting, reservoir storage simulations, and assessment of monitoring technologies as they apply to the project site were developed for the project. Plans to facilitate the next steps of the project will be the main work remaining in this portion of the project as the program moves toward the proposed capture and sequestration system.

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EXECUTIVE SUMMARY

This Quarterly Technical Progress Report for Contract DE-AC26-98FT40418 has been prepared in accordance with the requirements of the National Energy Technology Laboratory (NETL). The reporting period for the current document is April-June 2007.

The purpose of this project is to evaluate the geology of deep formations in the Ohio River Valley region and to conduct a long-term test of carbon dioxide (CO_2) injection/storage in deep saline formations at an active power plant site. The current technical progress report summarizes activities completed for the April-June 2007 period of the project. As discussed in the report, the main accomplishments related to preparation to move forward with a 100,000-300,000 metric tons CO_2/year capture and sequestration project at the Mountaineer site. The program includes a 10 to 30-megawatt thermal product validation at the Mountaineer Plant where up to 300,000 metric tons CO_2/year will be captured and sequestered in deep rock formations identified in this work. Design and feasibility support tasks proceeded for the project such as development of injection well design options, engineering assessment of CO_2 capture systems, permitting, reservoir storage simulations, and assessment of monitoring technologies. Plans to facilitate the next steps of the project will be the main work remaining in this portion of the project as the program moves toward the proposed capture and sequestration system.

1.0 INTRODUCTION

The main objective of this project is to evaluate the geology of deep formations in the Ohio River Valley region and to conduct a long-term test of carbon dioxide injection/storage in deep saline formations at an active power plant site if the project sponsors see fit. This work supports the overall project objective of demonstrating that CO_2 sequestration in deep formations is feasible from engineering and economic perspectives, as well as being an inherently safe practice and one that will be acceptable to the public.

2.0 EXPERIMENTAL

The main experimental activity undertaken during the reporting period was combined reservoir simulations of CO_2 injection into the Rose Run Sandstone and Copper Ridge Dolomite. Work also continued on design and feasibility support tasks designed to move the project toward an integrated carbon capture and storage system at the Mountaineer site.

3.0 RESULTS AND DISCUSSION

The following section summarizes the major activities and their outcomes for the reporting period under each task of the project.

Task 1 – Geologic Data Assessment

Task 1 includes subsurface geologic assessment in the vicinity of the field site based on pre-existing information. All activities under Task 1 of the Statement of Work have been completed, and Battelle has developed a thorough understanding of the geologic framework for the site's deep saline reservoirs, caprock formations, and coal seams. An Interim Topical Report on the findings was submitted to NETL in August 2003.

Task 2 – Seismic Survey

The main tasks related to the seismic survey have been completed, including design of a survey through injection well site, acquisition of 11 miles of seismic reflection data, data processing, interpretation of the results, analysis of the feasibility of seismic monitoring of CO_2 in the region, and reporting. Remaining elements of Task 2 include final determination of the monitoring arrangements for vertical seismic profiling and passive seismic monitoring, which will be completed at the end of the current phase.

Task 3 – Borehole Drilling and Testing

All major activities associated with Task 3 have been completed. A manuscript describing the borehole injectivity characterization efforts is being prepared for publication in a special AAPG issue on CO_2 sequestration.

Task 4 – Reservoir Simulations

Work continued on developing a combined model for the Rose Run and Copper Ridge formations so that the scenario for a dual completion well can be evaluated. The Rose Run sandstone and Copper Ridge b-zone intervals have been modeled as separate injection zones previously. Calculations were also initiated on the relationship between the bottom-hole pressure and the wellhead pressure requirements so that the compression and pipeline design can be finalized. Pilot-scale simulation results for injection into the Copper Ridge were examined to determine optimal monitoring well locations and aid in developing injection and monitoring well plans (Figure 1).

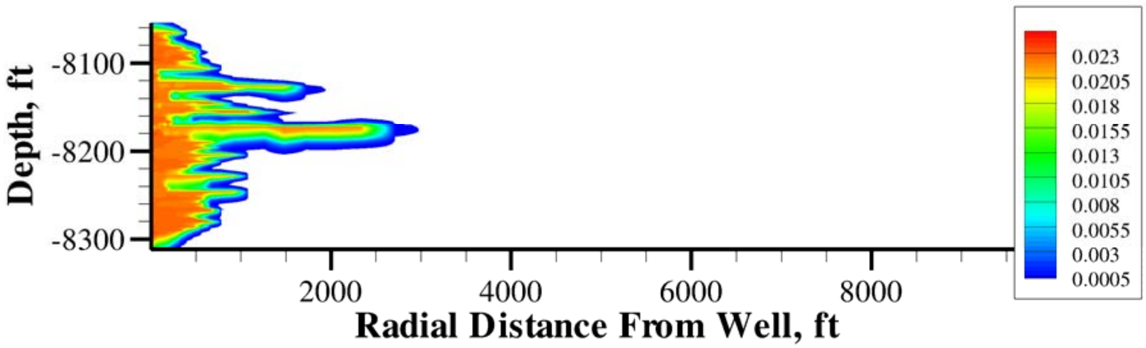

Figure 1. Pilot scale simulation results of CO_2 injection into the Copper Ridge Dolomite at 50,000 tonne/year for 4 years conducted in an effort to assess the optimum location for a monitoring well. Distributions of CO_2 in the aqueous phase show a plume with a radius that is generally less than 1000 ft, with a few stringers out to 3000 ft.

A set of 2D simulations for the Copper Ridge formation were completed, paralleling the stochastic analysis of the Rose Run that analyze multiple realizations of permeability distributions. New Rose Run and Copper Ridge "b-zone" simulations were run with hysteresis to determine the effect of relative permeability and saturation. Pilot scale simulations, including 165,000 tonnes/year split/full injection scenarios were completed for the Copper Ridge and Rose Run with the new STOMPCO2 well model, which gives better estimates of the well pressures for a constant injection rate.

Reservoir test results in the Copper Ridge "b-zone" were matched with the STOMPCO2 model, imposing the observed downhole pressures at the well, over the same 200-ft packer interval used, and scaling the permeabilities until they matched the observed flow rates. This calibration exercise to field tests provides much more certainty to the model. Additional configurations with lateral wells, multiple injection wells, and formation treatments are being considered to optimize injection system for the pilot-scale system.

Task 5 – Design the Future Injection and Monitoring Facility and Prepare Regulatory Permits

Much of the work in May-June was focused on design of the injection and monitoring facility, based on AEP's March announcement to construct up to 30-megawatt thermal scale product validation at the Mountaineer Plant where up to 300,000 metric tons CO_2/year will be captured and sequestered in deep rock formations. Initial plans were developed to determine general logistics, design, regulatory, and planning issues. Plans included a general evaluation of injection wells, monitoring program, injection system, any pipeline from the capture system, and chemical properties of the CO_2 from the capture system. Based on this early planning, more detailed design and engineering assessments will be developed for the proposed system. Regulatory aspects for the system were also examined in respect to the West Virginia permitting agencies.

Work continued to complete the techno-economic performance study of the available amine technologies to capture CO_2 from a slip steam of flue gas at the AEP Mountaineer power plant. Among the calculations being performed, progress has been made in constructing mass flow and energy balance worksheets for an amine-based CO_2 capture unit. To facilitate comparison of commercial amine systems a model system was created using MathCAD. Mass and flow parameters from Fluor and MHI process flow data were used in constructing the model. Low pressure steam requirements were calculated using vendor data as initial assumptions. Sensitivity analyses were performed to identify parameters that may be further optimized. MathCAD model output was used to build a more comprehensive process simulation was performed using ChemCAD. The ChemCAD model is able to simulate vapor pressures and chemical reactions more accurately. A summary of these two models is being prepared for the final report.

Study is also being conducted to provide detailed insight into thermal integration of the capture unit with the existing power plant. De-rating of the power plant due to the capture unit is also being studied. The model, once completed, for computing the energy balance around the capture unit will be included into the techno-economic performance study. A literature review is also being conducted on all available technologies for CO_2 capture to obtain information about these technologies pertaining to operating environment, cost breakup, advantages, and disadvantages. Battelle is also assessing the quality of the CO_2 streams in both, MHI and Fluor, units to match the outputs with suitable compression and pipeline transportation systems.

Other progress was made in understanding the steam cycle for Mountaineer plant, such as locating points where steam may be extracted, and estimating the implications for electric power generation. Battelle requested additional information from AEP's power plant engineering staff, which will be used to refine these calculations.

Task 6 – Risk Assessment and Stakeholder Interactions

Risk Assessment – Results from risk assessment efforts were compiled for a topical report.

Stakeholder Outreach – Initial stakeholder outreach plans were developed to support the pilot scale capture and sequestration project. A team from Battelle and AEP was assembled to help complete the stakeholder outreach plans. A general schedule was determined with a team from Battelle and AEP. A "frequently asked questions" sheet was prepared by Battelle and AEP on the pilot scale capture and injection project. Plant meetings were held on June 25-26 for Mountaineer staff to inform the workers on the pilot scale project as a first step in the outreach program. Media and stakeholder reaction to the AEP announcement about the future phases of the project was monitored.

Task 7 – Project Briefings and Meetings

- April 2007. Presented CCS technology progress and the Mountaineer project overview at the Lab Energy R&D Working Group (LERDWG) meeting hosted by NETL in Washington DC.
- May 7, 2007. Planning meeting with AEP held at Battelle Columbus office to determine schedule, general logistics, and critical near-term issues necessary to prepare for the injection-scale testing under task 5 of the current project
- May 17, 2007. Stakeholder outreach Conference call with AEP and Battelle to develop FAQ sheet and plant meeting schedule.
- A presentation entitled "Assessment of CO_2 Injection Potential in the Copper Ridge Formation at the Mountaineer Power Plant Site" was prepared for the Sixth Annual Carbon Sequestration Conference, May 7 - 10, 2007.
- June 8, 2007. Neeraj Gupta attended a Permitting meeting with West Virginia DEP, Battelle, and AEP to discuss Underground Injection Control permitting timeline, issues, and workflow for the Mountaineer storage project.
- June 14, 2007. Stakeholder outreach Conference call with AEP and Battelle to finalize FAQ sheet and plant meeting schedule.
- June 25, 2007. Neeraj Gupta and Diana Bacon supported plant meetings at the Mountaineer Plant in New Haven, West Virginia to introduce the CCS project to plant staff.
- June 26-27, 2007. Joel Sminchak presented results of Reservoir Fluid Sampling experience at the Mountaineer test well at the Schlumberger-Westbay CO_2 Groundwater Monitoring Workshop in Vancouver, Canada.

Task 8 – Building the Regional Geologic Framework
No significant activity.

4.0 CONCLUSION

Overall, the current design feasibility phase of the project has made significant progress toward implementing a 100,000-300,000 metric tons CO_2/year capture and sequestration project at the Mountaineer site. Substantial progress was also made on pilot-scale capture system assessment for advanced amine systems for a pilot-scale CO_2 capture and injection demonstration at the Mountaineer site. Reservoir simulations were also completed to analyzed proposed injection system for the Rose Run sandstone and Copper Ridge “b-zone.” Plans to facilitate the next steps of the project will be the main work remaining in this portion of the project as the program moves toward the proposed capture and sequestration system. As a first-of-its-kind system, this work involves numerous challenges, but diverse resources are being utilized to meet the challenges.

4.1 Future Activities

With the announcement of the capture and sequestration system for the Mountaineer Plant, the project will shift to preparing for this effort. During the next few months, the following areas of emphasis are anticipated:

- Further develop plans for proposed injection system at the Mountaineer Plant.
- Completing reservoir simulations of injection in the Copper Ridge dolomite and possibly dual-completion options.
- Evaluate injection well and monitoring design scenarios based on modeling results
- Explore avenues for continued participation by the current project sponsors and additional members in the demonstration phase of the project.
- Complete Phase III site characterization report and reservoir simulation reports.

5.0 REFERENCES

No references cited.